GEOPHYSICAL SUBSURFACE PROFILING OF KUANTAN BAUXITE FORMATION

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Date : 30 MAY 2019

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Thesis submitted in fulfillment of the requirements
for the award of the
B. Eng (Hons.) Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my supervisor Prof Madya Dr Haryati bt Awang for her germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. She has always impressed me with her outstanding professional conduct, her strong conviction for science and her belief that a degree program is only a start of a life-long learning experience. I appreciate her consistent support from the first day I applied to graduate program to the concluding moments. I am truly grateful for her progressive vision about my training in science, her tolerance of my naïve mistakes and her commitment to my future career. I also would like to express very special thanks to my co-supervisor Dr Nurul Nadrah Aqilah bt Tukimat for her suggestions and co-operation throughout the study. I also sincerely thanks for the time spent proof reading and correcting my many mistakes.

My sincere thanks go to all my lab mates and members of the staff of the Civil Engineering Department, UMP, who helped me in many ways and made my stay at UMP pleasant and unforgettable. Many special thanks go to member engine research group for their excellent co-operation, inspirations and supports during this study.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I acknowledge the sincerity of my parent, who consistently encouraged me to carry on my studies in Malaysia. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my cluster members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRAK

Kajian ini memberi tumpuan kepada profil bawah tanah geofizik pembentukan bauksit Kuantan. Pada masa lalu, pensampelan konvensional, lubang gerek yang digabungkan dengan Mackintosh Probe (MP) digunakan untuk tujuan untuk menyiasat permukaan bawah tanah. Walau bagaimanapun, MP adalah sangat mahal dan mengambil masa yang lama. Objektif kajian ini adalah untuk mengkaji kaedah geofizik untuk menentukan profil bawah permukaan dengan menggunakan imej rintangan dan untuk mengaitkan data rintangan elektrik dan MP. Hasil profil gambar menunjukkan bahawa ketahanan tanah bergantung pada jenis tanah dan pembentukan tanah. Oleh itu, profil imej yang dijana oleh perisian menunjukkan pengimejan bawah tanah geofizik dalam maya. Data dari hasil ujian MP ditabulasi untuk mewakili kekerasan tanah dan data rintangan elektrik diinterpretasikan untuk mengaitkan kedua-dua hasil tersebut. Korelasi ini bergantung pada kedalaman dari permukaan tanah terhadap jumlah ketukan mackintosh dan rintangan tanah. Semakin besar nilai rintangan, lebih banyak ketukan mackintosh. Ia dapat menyimpulkan bahawa peningkatan rintangan selari dengan ketukan mackintosh.

ABSTRACT

This research focuses on the geophysical subsurface profiling of Kuantan bauxite formation. At the past time, the conventional, borehole sampling incorporated with Mackintosh Probe (MP) is used for a purposed to investigate the subsurface of the soil. However, the MP is very costly and lengthily. The objective of this research is to study the geophysical method to determine the subsurface profile by using resistivity image and to correlate the data of electrical resistivity and MP. The result of image profile was illustrated that the resistance of soil is depended on type of soil strata and soil formation. As a result, the image profile generated by the software demonstrated in virtual the geophysical subsurface soil imaging. The data from results of MP test was tabulated to represent the hardness of the soil and the data of electrical resistivity was interpreted to correlate with the both result. The correlation intersection is depended on the depth from ground surface against the number of mackintosh blows and soil resistivity. The more the value of resistivity, the more the Mackintosh blows. It can conclude that the resistivity increase proportional with mackintosh blows.

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LIST OF SYMBOLS

$Al(OH)_3$	Gibbsite
AlO(OH)	Boehmite and Diaspore
Al_2O_3	Alumina
Fe_2O_3	Iron oxide
SiO_2	Silica
Ωm	Ohm.m
R^2	Coefficient of Determination

LIST OF ABBREVIATIONS

SI	Site Investigation
ERI	Electrical Resistivity Imaging
MP	Mackintosh Probe
SPT	Standard Penetration Test
DC	Direct Current
GPS	Global Positioning System
RL	Resistivity Line

CHAPTER 1

INTRODUCTION

1.1 Introduction

Bauxite refers to any ore or mixture of minerals consisting of iron and aluminum hydroxides/oxides. The ore in most instances comprise of minerals such as gibbsite [$Al(OH)_3$], diaspore and boehmite [both AlO(OH)] (Plunkert, 2000). A bauxite body which is economically mineable at present or in the foreseeable future, currently should have chemical composition of >45% Al_2O_3, <20% Fe_2O_3 and <5% SiO_2 (Gow & Lozej, 1993). Malaysia is now the world's top producer of bauxite.

One of the largest bauxite productions in Malaysia is located in state of Pahang including the Kuantan area. Figure 1.1 shows the location of bauxite in Kuantan which is located at Felda Bukit Goh.

Figure 1.1: The location of Felda Bukit Goh in Kuantan

In 2014 and 2015, bauxite area became a mining place to get the minerals such as boehmite and gibbsite that can be extracted to become aluminium. However, in Kuantan, mining activity was banned by the government because of the majority of the miners do not follow the right procedure to operate the mining process. Therefore, some companies want to harness the mining region as a development area in addition to overcome the limitation of residential area in Kuantan. So, site investigation (SI) should be conducted to determine the soil information of the bauxite area.

Site investigation is very important to get the information and data related to the site that normally compiled into a report that known as site investigation (SI) report. Therefore, the most suitable SI method should be identified according to the condition of the site. For example, when doing site investigation at a bauxite site in Kuantan, geophysical method can be proposed as an alternative method for site investigation. Figure 1.2 shows a bauxite site in Kuantan.

Figure 1.2: A bauxite site in Kuantan

This study is carried out as a preliminary assessment of geophysical survey for subsurface profiling. The purpose is to determine the profiling of the soil and probably the extent of the bauxite deposit under the ground surface for the future use.

1.2 Problem Statement

Nowadays, majority of bauxite site in Kuantan becomes construction area due to the residential and commercial need. Therefore, site investigation should be carried out at the area to get the important information and data before the engineer can design a foundation and other structures of the building.

The current practice that is used to obtain the information is by borehole drilling. To ensure that the drilling work is cost effective, it is very important that the location and depth are well planned and optimised to meet construction requirements and ground conditions. A borehole will provide single point data of the subsurface which is needed for the site investigation report. The data will be more accurate if the number of the drilling borehole is increased, but it will risk the cost of the site investigation process. Therefore, there is a geophysical method to overcome the problem which is Electrical Resistivity Imaging (ERI).

ERI is a measurement of ground resistivity involves passing an electrical current into the ground using some equipment such as electrode and transmitter. This method will provide a continuous profile of the subsurface along the survey line. Therefore, site investigation data will be obtained easily with cost effectively.

Based on the above problem, this study is carried out to investigate the subsurface of the bauxite deposit area in Kuantan using ERI. The method of Mackintosh Probe (MP) will also to be carried out at few points along the resistivity line.

1.3 Objectives of Study

The objective of this study is to address important issues pertaining to the above mentioned problems which are listed as follows:

1) To determine the profiling of the bauxite site in Kuantan

2) To correlate between the resistivity and MP number of blows of the bauxite site in Kuantan

REFERENCES

A, Z., S, A. R., Y, W. Z., & Y, J. (2012). Groundwater investigation using electrical resistivity imaging technique at Sg . Udang , Melaka , Malaysia, *58*(December), 55–58.

Abidin, M. H. Z., Madun, A., Tajudin, S. A. A., & Ishak, M. F. (2017). Forensic Assessment on Near Surface Landslide Using Electrical Resistivity Imaging (ERI) at Kenyir Lake Area in Terengganu, Malaysia. *Procedia Engineering*, *171*, 434–444. https://doi.org/10.1016/j.proeng.2017.01.354

Ali, M. S. M. (2017). *Middle Eocene echinoids from Gebel Qarara, Maghagh, Eastern Desert, Egypt*. *Journal of African Earth Sciences* (Vol. 133). https://doi.org/10.1016/j.jafrearsci.2017.04.031

Barker R.D., 1996. The application of electrical tomography in groundwater contamination

studies. EAGE 58th Conference and Technical Exhibition Extended Abstracts, P082.

Batayneh, A. T., & Diabat, A. (2002). Application of a two-dimensional electrical tomography technique for investigating landslides along the Amman – Dead Sea highway , Jordan, (July). https://doi.org/10.1007/s00254-002-0543-x

Beauvais, A., Parisot, J., & Savin, C. (2007). Ultramafic rock weathering and slope erosion processes in a South West Pacific tropical environment Ultramafic rock weathering and slope erosion processes in a South West Pacific tropical environment, (January). https://doi.org/10.1016/j.geomorph.2006.06.016

Bond, D. R., & Lovley, D. R. (2003). Electricity Production by Geobacter sulfurreducens Attached to Electrodes, *69*(3), 1548–1555. https://doi.org/10.1128/AEM.69.3.1548

Christensen, N. B., & Sørensen, K. I. (1994). Integrated Use of Electromagnetic Methods for Hydrogeological Investigations. *Symposium on the Application of Geophysics to Engineering and Environmental Problems*, (January), 163–176. https://doi.org/10.4133/1.2922061

Daniels, F. and Alberty,R.A. 1966. Physical chemistry, John Wiley & Sons,Inc.

David, I., & Weinstein, H. (1976). United States Patent (19), (19).

Eleraki, M., Gadallah, M. M., Gemail, K. S., & Attwa, M. (2010). Application of resistivity method in environmental study of the appearance of Application of resistivity method in environmental study of the appearance of soil water in the central part of Tenth of Ramadan City , Egypt, (April 2014). https://doi.org/10.1144/1470-9236/08-079

Fakher, A., & Khodaparast, M. (2006). The use of the Mackintosh Probe for site investigation in soft soils, *30*(1995), 189–196.

Gow, N. N. and Lozej, G. P. (1993). Bauxite; Geoscience Canada, Vol20, Number 1, pp 9–16.

Hauck, Christian & Kneisel, Christof. (2006). Application of capacitively-coupled and DC electrical resistivity imaging for mountain permafrost studies. Permafrost and Periglacial Processes. 17. 169 - 177. 10.1002/ppp.555.

ICRC. (2010). Technical Review Borehole Drilling and Rehabilitation Under Field Conditions, 130. https://doi.org/0998/002 02.2010 1.000

Keller,G.V.and Frischknecht,F.C.1966. Electrical methods in geophysical prospecting, Oxford , Pergamon Press Inc.

Lagmansson, M., 1998. Marine resistivity survey. Advanced Geosciences Inc. web site (www.agiusa.com).

Loke, M. H. (2000). Electrical imaging surveys for environmental and engineering studies - A practical guide to 2-D and 3-D surveys, (1999), 63.

Maillet, M., & Rizzo, E. (2005). High Resolution Electrical Resistivity Tomography (ERT) in a Transition Zone Environment : Application for Detailed Internal Architecture and Infilling Processes Study of a Rhône Ri ... High resolution electrical resistivity tomography (ERT) in a transition zone environment : Application for detailed internal architecture and infilling ˆ ne River paleo-channel processes study of a Rho, (June). https://doi.org/10.1007/s11001-005-3726-5

Margielewski, Włodzimierz. (2006). Structural control and types of movements of rock mass in anisotropic rocks: Case studies in the Polish Flysch Carpathians. Geomorphology. 77. 47-68. 10.1016/j.geomorph.2006.01.003.

Plunkert, P.A. (2000). Bauxite and alumina: U.S. Geological Survey Mineral Commodity Summaries 2000, p. 32-33.

Rogers, J. D. (2006). Subsurface Exploration Using the Standard Penetration Test and the Cone Penetrometer Test, *XII*(2), 161–179.

Schrott, L., & Sass, O. (2015). Application of field geophysics in geomorphology : Advances and limitations exemplified by case studies Application of field geophysics in geomorphology : Advances and limitations exemplified by case studies, *2015*(March 2018). https://doi.org/10.1016/j.geomorph.2006.12.024

Soupios, P., & Kokinou, E. (2017). T ECHNIQUES , ADVANTAGES AND LIMITATIONS, (February 2016).

S t a r k e l L., 1997. Mass-movements during the Holocene: the Carpathian example and the European perspective, [in:] Rapid mass movement as a source of climatic evidence for the Holocene, ed. B. Frenzel, Palaeoklimaforschung/Palaeclimate Research 19, 385–400.

Valenta, J. (2015). Introduction to Geophysics – Lecture Notes.

Zhou, W & F. Beck, B & B. Stephenson, J. (2000). Reliability of dipole-dipole electrical resistivity tomography for defining depth to bedrock in covered karst terranes. Environmental Geology. 39. 760-766. 10.1007/s002540050491.